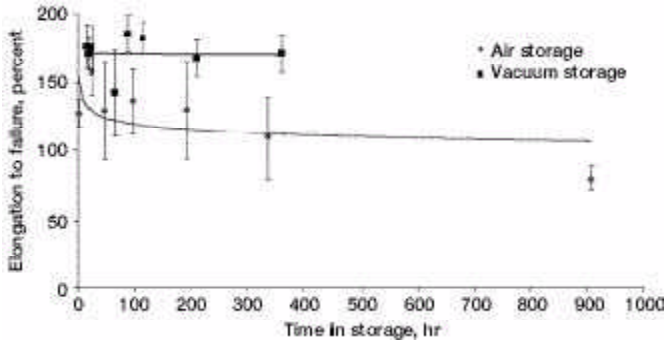
Effect of Air and Vacuum Storage on the Degradation of X-Ray-Exposed Aluminized-Teflon Investigated

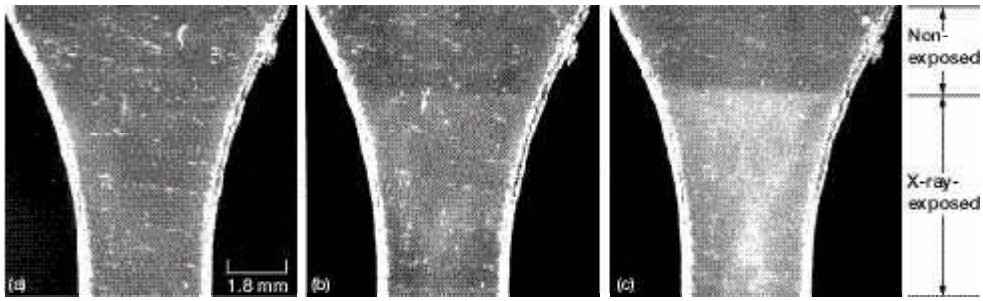
Metalized Teflon FEP (fluorinated ethylene propylene, DuPont), a common thermal control material, has been found to degrade in the low-Earth-orbit space environment. The aluminized-FEP (Al-FEP) exterior layer on the Hubble Space Telescope has become extremely embrittled, with extensive cracking occurring on all sides of the telescope. This embrittlement has been primarily attributed to radiation exposure (x-rays from solar flares, electron/proton radiation, and possibly near-ultraviolet radiation) combined with thermal cycling. Limited samples of FEP tested after long-term exposure to low Earth orbit on the Hubble Space Telescope and on the Long Duration Exposure Facility indicated that there might be continued degradation in tensile properties over time. An investigation was conducted at the NASA Glenn Research Center to evaluate the effect of air and vacuum storage on the mechanical properties of x-ray-exposed FEP.



Percent elongation to failure for x-ray-exposed Al-FEP samples stored in air and under vacuum.

Aluminized-FEP (5-mil-thick) tensile samples were x-ray exposed with 15.3-kV copper x-rays for 2 hr, reducing the percent elongation to failure by approximately 50 percent in comparison to that for pristine Al-FEP. X-ray-exposed samples were stored in air or under vacuum for various time periods to see the effect of storage on tensile properties. Tensile results indicated that samples stored in air had larger decreases in tensile properties than samples stored under vacuum had, as seen in the graph. Samples stored under vacuum (for up to 400 hr) showed no further decrease in tensile properties over time, whereas samples stored in air (for up to 900 hr) appeared to show decreases in tensile properties over time. X-ray-exposed samples stored in air developed a hazy appearance in the exposed area, as seen in the photographs. When the source of the haziness was evaluated using scanning electron microscopy and atomic force microscopy, it was found to reside at the Al/FEP interface as witnessed by an increased surface roughness of the aluminized side of the material and a dramatic decrease in the adhesion between the Al and FEP. Optical properties of air-stored irradiated samples showed an increase in the diffuse reflectance, which is consistent with observed roughening that was characterized by AFM. These

findings indicate that air exposure helps degrade x-ray-irradiated FEP. These results indicate that proper sample handling and storage is necessary with space-retrieved materials and with those exposed to ground-based irradiation simulation exposures.



Development of hazy appearance in an x-ray-exposed Al-FEP sample after various durations of air storage. (a) 25 min. (b) 27 hr. (c) 118 hr.

Find out more from Glenn's Electro-Physics branch (http://www.grc.nasa.gov/WWW/epbranch/ephome.htm)

Glenn contact: Kim K. de Groh, 216-433-2297, Kim.K.deGroh@grc.nasa.gov
Authors: Kim K. de Groh and Jonathan D. Gummow
Headquarters program office: OSS
Programs/Projects: HST, ISS